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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 10/017,560 | 12/14/2001 | Dmitriy G. Repin | 94.0041 | 8066 |

7590

10/03/2003

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EXAMINER

NGUYEN, KIMBINH T

ART UNIT

PAPER NUMBER

2671

DATE MAILED: 10/03/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|--------------------------------------|-------------------------------------|--|
| Office Action Summary | Application No. 10/017,560 | Applicant(s) REPIN ET AL. | |
| | Examiner Kimbinh T. Nguyen | Art Unit 2671 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 14 December 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 8-13 and 21-27 is/are allowed.
- 6) ☒ Claim(s) 1,2,7,14,15,20 and 28 is/are rejected.
- 7) ☐ Claim(s) 3-6 and 16-19 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 14 December 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>2</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. Claims 1-28 are pending in the application.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Malzbender et al. (6,278,459).

Claims 1 and 14, Malzbender et al. discloses rendering a volume of voxel data with shading and opacity (col. 3, lines 40-45; fig. 1), wherein each voxel comprises a value representative of a parameter at allocation within the volume, each voxel has an initial value of opacities (col. 3, lines 41-45; fig. 1A, #18; fig. 2A α either equals to 0 or 1), comprising: calculating revised value of opacity of voxels (the voxel opacities are fed back to the color processing branch to be used in an opacity weighting step to produce a set of opacity weighted color; col. 3, lines 49-51; col. 9, lines 11-13), the revised value depends upon initial value of opacity (where α is 0; col. 5, line 55; or where α is 1, a fully opaque region, fig. 2A and fig. 2B); calculating an opacity gradient of voxels using the calculated revised values of opacity (col. 3, lines 52-57; col. 9, lines 14-18). Malzbender does not suggest the revised value of opacity (the opacity weighted

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color) depends upon initial value of opacity; however, Malzbender teaches the voxel opacities are fed back to the color processing branch to be used in an opacity weighting step to produce a set of opacity weighted color; col. 3, lines 49-51; col. 9, lines 11-13; proper calculation of resampled colors is done by weighting each source voxel color value by the initial opacity α . These weighted colors are then interpolated, as are the opacity values (col. 5, lines 39-42); these features related to the revised value of opacity (opacity weighted color) depends upon initial value of opacity (α equals to 0 or equals to 1). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the opacity weighted interpolator as taught Malzbender for calculating the opacity value at each sample point along the plurality of rays, because performing the opacity weighting calculation based on the initial opacity value, it would eliminate artifacts resulting from zero opacity area (col. 2, lines 34-37).

4. Claims 2 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Malzbender et al. (6,278,459) in view of Drebin et al. (4,835,712).

Claims 2 and 15, Drebin et al. discloses creating a cell surrounding each voxel (cells 78,76,74,72, 70; fig. 5), all voxels in each cell are arranged into groups (groups red, green, blue, opacity; fig. 7) so that each voxel in each group are positioned one behind the other in a line parallel to the light direction (figs 8 and 10). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the volume gradient in 3D (voxels) as taught by Drebin into opacity weighted color interpolation for volume sampling disclosed by Malzbender's method for determination of the gradient for each voxel, because the interpolation is successively

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performed for all voxels (or groups of voxels) up to the front most voxel for the plane of view, it would provide a high degree of precision and definition that is independent of image volume on a per voxel basis (col. 2, lines 54-56).

5. Claims 7, 20 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Malzbender et al. (6,278,459) in view of Doi et al. (5,499,323).

Claims 7 and 20, Doi et al. discloses calculating shading for the volume using the opacity gradient (col. 3, lines 1-9; col. 6, lines 29-50); displaying the rendered volume (col. 4, lines 60-62; col. 6, lines 19-20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the method of shading calculated from the volume data and opacity values as taught by Doi's method into opacity weighted interpolation method taught by Malzbender for volume rendering, because it would provide a quickly processing by tabulating various values for use in the calculation of emphasized opacity (col. 3, lines 10-12).

Claim 28, the rationale provided in the rejection of claims 1 and 7 is incorporated herein. In addition, Malzbender et al. discloses a computer readable medium (a personal computer, CPU, random access and disk memories; col. 3, lines 63-66).

Allowable Subject Matter

6. Claims 8-13 and 21-27 allowed.

7. Claims 3-6, 16-19 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

Claims 3-5 disclose the volume rendering comprising: setting the revised value of opacity closest to the light source of voxels in each cell equal to initial value of opacity; setting the revised value of all other voxels in each cell equal to the revised value of an adjacent voxel in the same group that is closer to the light source if the revised value of the closer voxel is equal to or greater than the initial value of opacity of the adjacent other voxel, and setting the revised value of the adjacent other voxel equal to initial value if the revised value of the closer voxel is less than the initial value of opacity of the adjacent other voxel; combining the revised values opacity in each cell to derive three orthogonal opacity gradient components in the center of each cell; combining three orthogonal opacity gradient in the center to derive an opacity gradient that is normal to an isosurface passing the voxel in the center; combining the revised values of opacity for the voxels in each cell to derive three orthogonal opacity gradient components for the voxel in the center of each cell; and combining the three orthogonal opacity gradient components for the voxel in the center of each cell to derive an opacity gradient that is normal to an isosurface passing through the voxel in the center of each cell. The closest prior art, Malzbender (6,278,459) teaches revised value of opacity (opacity weight color), Drebin et al. (4,835,712) teaches computing a 3D gradient at the center of each RGBA voxel based on the opacity of neighboring voxels (col. 3, lines 37-49), either singularly or in combination, fails to anticipate or render the above underlined limitations obvious.

Claim 6, which dependent upon claims 4, and is allowed on the same reasons set forth in claim 4.

Claims 16-19 are allowed on the same reasons set forth in claims 3-6.

Claims 8-13 and 21-27 are allowed on the same reasons set forth in claims 3-5.

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- Goto (5,617,521) teaches 3D image shading method using volume rendering of shading pixel area having a small pixel value gradient.
- Kaufman et al. (5,760,781) teaches apparatus and method for real-time volume visualization.
- Szeliski et al. (5,917,937) teaches method for performing stereo matching to recover depths, colors and opacities of surface elements.
- Drebin et al. (5,381,518) teaches method and apparatus for imaging volume data using voxel values.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Kimbinh Nguyen** whose telephone number is **(703) 305-9683**. The examiner can normally be reached **(Monday- Thursday from 7:00 AM to 4:30 PM and alternate Fridays from 7:00 AM to 3:30 PM)**.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Zimmerman, can be reached at (703) 305-9798.

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Any response to this action should be mailed to:

Commissioner of Patents and Trademarks

Washington, D.C. 20231

Or faxed to:

(703) 872-9314 (for Technology Center 2600 only)

Hand-delivered responses should be brought to Crystal Part II, 2121 Crystal Drive,
Arlington, VA, Sixth Floor (Receptionist).

Any inquiry of a general nature or relating to the status of this application or
proceeding should be directed to the Technology Center 2600 Customer Service Office
whose telephone number is (703) 306-0377.

September 25, 2003



Kimbinh Nguyen

Patent Examiner AU 2671